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(54) METHOD AND APPARATUS FOR THE MANUFACTURE OF HOLLOW BODIES FROM THERMOPLASTIC SYNTHETIC MATERIAL BY ROTARY FUSING

(71) I, HERBERT GIEHLER, a German citizen of 42 Geisbergstrasse, Koln-Klettenberg, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

It is known to manufacture hollow bodies from synthetic plastics material by rotational moulding. Essentially the method consists in partially filling a mould which corresponds to the outer shape of the desired hollow body with a synthetic thermoplastics material, the mould being heated, being rotated about two mutually inclined planes, and subsequently being allowed to cool to give the intended moulded end product.

The rotational moulding method is applied in slightly differing manner depending upon the material used. It is known to effect variations in the plastisols used, such as, for example, polyvinyl-chloride paste, polyolefine such as polyethylenes and polypropylenes, as well as polystrol and polymethylmethacrylate, and others. In the moulding of synthetic materials which gelatinise on heating, such as polyvinyl chloride paste, it is sufficient for the mould to rotate during the heating phase and up to gelatising of the synthetic material. During the cooling phase the mould may be at rest. With the working of fusible synthetic materials on the other hand the mould must also rotate during the cooling stage. For this, the synthetic material is introduced into the mould as a flowable powder and the powder is heated during rotation of the mould until the contents thereof are completely melted. The mould is then cooled, rotation being maintained until the contents are solidified.

It is known, in practising this method wherein the mould is rotated during both the heating and cooling phases to apply a negative pressure to the interior of the mould during the heating phase. In this way an improvement in the surface of the moulded object is attained and the formation of bubbles in the synthetic plastics material is counteracted.

Even with the various modifications of the method the choice of the synthetic material to be moulded is still restricted. The method is limited essentially to the moulding of polyvinyl chloride and polyethylene. These plastics can be satisfactorily moulded, but one cannot produce therefrom all articles which one would like to produce by the rotational moulding method because of the difficulties associated therewith. The method renders possible, as is known, by comparatively simple means, the manufacture of hollow bodies of uniform wall thickness. The problem of manufacturing objects having clear, satisfactorily fused walls of impact resistant synthetic material is not yet solved. Polymethylcrylates may be moulded into objects having clear, satisfactorily fused walls but the temperature difference between the fusing temperature and the temperature of breakdown due to overheating of the plastics material is so small that in practice great difficulties arise. Objects moulded from this material are not entirely satisfactory in respect of mechanical strength.

Polystyrol and polyolefines free of softeners have likewise scarcely any significance for the rotational moulding method because the objects produced therefrom do not have sufficient mechanical strength.

The use of cellulose derivatives, in particular cellulose acetate, cellulose azotobutyrate and cellulosepropionate, in the manufacture of objects by rotational moulding would signify a considerable broadening of the field of application of the method. One could produce clear objects with satisfactory impact resistance and mechanical strength

but the use of these synthetic materials is subject to considerable restrictions. These restrictions are based on the proportion of softener in the synthetic materials.

The very satisfactorily workable polyvinyl-chloride pastes contain softeners and are in the form of dispersions of polyvinyl-chloride powder in softeners. The softeners are, upon heating of the mass, bonded to the polyvinyl chloride and the mass gelatinizes. In the manufacture of moulded objects from fusible plastics materials such as cellulose azobutyrate, cellulose propionate and cellulose acetate, on the other hand, the softener is not bonded to the cellulose derivative and it is necessary to produce a true solution of the cellulose derivative in the softener. The properties of these synthetic materials containing a portion of softener such as is most favourable for imparting high impact resistance and mechanical strength to the moulded object are not such as to permit satisfactory moulding by the rotary fusing method. Softener losses during the heating phase lead to the drawback that the impact resistance of the moulded object is unsatisfactory. Moreover, moulded objects having a satisfactory surface and without bubble inclusions are not obtained without trouble. The employment of a negative pressure in the mould during the heating phase does not lead to satisfactory results. The properties of the moulded objects fluctuate uncontrollably from extreme brittleness, and thus liability to break, to satisfactory

An apparatus for carrying out the rotational moulding method consists of a mould mechanical strength and impact resistance. with two walls leaving a hollow space in between whereby the hollow space between the mould walls is capable of being filled with a liquid medium. The mould consists of abutting halves which are connected to one another by means of flanges fitting on one another. It is disposed in a holding means rotatable about two axes and the inside of the mould is connected by means of a tube to a source of vacuum.

Such an apparatus has the drawback that due to wear resulting from repeated use, the mould after a time is no longer closeable so as to be gas-tight. If the mould is not gas-tight, the employment of a negative pressure in the mould results in considerable material faults in the form of holes, oxidation phenomena and burning along the junction of the halves of the mould.

An object of the present invention is improving the rotary fusing moulding method such that objects of uniform and satisfactory quality can be moulded from cellulose derivatives such as cellulose acetate, cellulose azobutyrate and cellulose propionate.

Another object of the invention is providing an apparatus for carrying out the method in accordance with the invention.

According to the present invention a method for the manufacture of hollow shaped articles of synthetic thermo-plastics materials comprising cellulose derivatives and a softener by rotary moulding involving heating and cooling phases wherein the mould, which is formed of abutting halves during both the heating and the cooling phases, is continually rotated about two mutually inclined axes and wherein during the heating phase a negative pressure is produced in the mould and the pressure in the mould, on transition to the cooling phase, is increased by introducing an inert gas into the mould, characterised in that an excess of the softener over that required to produce the desired properties in the shaped object is added to the cellulose derivative and the excess softener, during the heating phase, is distilled from the mould.

In a preferred embodiment of the method according to the invention a negative pressure is maintained between the abutting faces of the mould halves and during the cooling phase the inert gas is introduced into the mould until the pressure in the mould is up to 1 atmosphere.

According to the present invention also, an apparatus for the manufacture of hollow shaped objects comprises a mould consisting of abutting halves connected by means of flanges fitting on one another and mounted in holding means for rotation about two mutually inclined axes, the mould being of double-wall construction having a hollow space between the walls, the hollow space between the mould walls being capable of being filled with a liquid medium, and the interior of the mould being connected by means of a pipe via a rotation joint to a source of vacuum and the mould having an inlet for an inert gas, characterised in that the flange of at least one of the mould halves has a groove therein forming an annular hollow space between the two flanges and extending parallel to the periphery of the flange, which groove is connected by a pipe to a source of vacuum. Preferably this latter source of vacuum, in its turn, is connected by a pipe through a non-return valve to the pipe connecting the interior of the mould to a source of vacuum, at a position between the mould and the rotation joint.

In a preferred embodiment of the apparatus according to the invention there is provided, between the non-return valve and the connection to the pipe connecting the mould to a source of vacuum, a separator for softener distilled from the mould during the heating phase.

The method and apparatus according to

the invention will now be described further, by way of example only, with reference to the accompanying drawings in which

Fig. 1 shows diagrammatically the rotating part of the apparatus, and

Fig. 2 shows a section through the flange part of the abutting mould halves.

Referring now to the drawing, the apparatus consists essentially of a two-part double-walled mould 1*a*, 1*b* mounted in a holding means, not shown, for rotation about two matually inclined axles. The hollow space 2*a*, 2*b* between the mould walls may be filled with a liquid medium, for example oil. The two halves 1*a*, 1*b* of the mould are connected by co-operating flanges 3*a*, 3*b* which fit together and which are held together for example by screw clamps or the like in manner known per se (not shown).

With spherical moulds, for the further sealing of the flanges 3*a*, 3*b* grooves 4*a*, 4*b* respectively are provided in the peripheral surfaces thereof, a sealing ring 5, made of silicon rubber, being located in such grooves. With moulds of other shapes a groove is formed in one, at least, of the flanges, a circular cord or sealing ring of silicon rubber being located in such groove.

A pipe 6 connects the interior of the mould to a source of vacuum through a rotary connection or joint 7 and through mould mounting means.

The inner face of flange 3*a* is provided with a groove, such groove forming an annular hollow space 9 between the abut-connected to a source of vacuum 11 by means of a tube 10, such source of vacuum being connected in its turn to a non-return ting flanges 3*a*, 3*b*. The hollow space 9 is valve 13 via a pipe 12, the valve 13 being connected to the pipe 6 intermediate the rotating joint 7 and the mould half 1*a*. A separator 14 is provided between the non-return valve 13 and the pipe 6, the separator 14 being intended to collect any softener distilling from the mould.

The method and operation of the apparatus are as follows:

After the mould, has, in manner known per se, been charged with synthetic material and heating of the mould has commenced, a negative pressure is produced at the interior thereof. Whereas in the case of a conventional mould a gas-tight seal cannot be attained at the flange so that air constantly flows inwardly of the mould at the joint between the halves thereof to preclude the formation of a closed synthetic material layer and give rise to holes and oxidation phenomena along the mould separating line, with the mould according to the invention inward flow of air is avoided in that between the two flanges 3*a*, 3*b* a negative pressure is produced. On transition from the heating phase to the cooling phase, inert gas is introduced into the interior of the mould to increase the pressure therein. During this pressure transition, the non-return valve 13 is effective. The volume of the vacuum source 11 is sufficient to maintain a negative pressure in the space 9 between the flanges 3*a*, 3*b* until solidification of the synthetic material takes place in the mould.

The separator 14 filters out any softeners which distil from the mould during the heating phase and prevents such softeners from reaching the non-return valve 13 and adversely affecting the operation thereof.

The invention is not restricted to the exact features of the embodiment hereinbefore described since alternatives will readily present themselves to one skilled in the art. Thus, for example, in additional to the non-return valve 13, or as an alternative thereto an electro-magnetically actuated shut-off valve may be fitted in the pipe 6 between the vacuum source 11 and the mould half 1*a*.

WHAT I CLAIM IS :—

1. A method for the manufacture of hollow shaped objects from synthetic themoplastics materials comprising cellulose derivatives and a softener by rotary moulding involving heating and cooling phases wherein the mould, which is formed of abutting halves is continually rotated during both the heating and cooling phases about two mutually inclined axes and wherein during the heating phase a negative pressure is produced in the mould and the pressure in the mould, on transition to the cooling phase, is increased by introducing an inert gas into the mould, characterised in that an excess of the softener over that required to produce the desired properties in the shaped article is added to the cellulose derivative and the excess softener is distilled from the mould during the heating phase.

2. A method according to claim 1 wherein, a negative pressure is maintained between the abutting faces of the halves of the mould and during the cooling phase the inert gas is introduced into the mould until the pressure in the mould is up to 1 atmosphere.

3. Apparatus for the manufacture of hollow shaped objects by the method according to claim 1 or 2 comprising a mould consisting of abutting halves connected by co-operating flanges and mounted in holding means for rotation about two mutually inclined axes, the mould halves being of double wall construction and having a hollow space between the walls to receive a liquid medium, the interior of the mould being connected by means of a pipe via a rotating joint to a source of vacuum and the mould having an inlet for an inert gas, characterised in that the flange of at least one mould half has a groove therein forming

an annular hollow space between the co-operating flanges and extending parallel to the periphery of the flange, which groove is connected by means of a pipe to a source of vacuum.

4. Apparatus according to claim 3 wherein the groove in the flange is connected to a source of vacuum which, in its turn, is connected through a non-return valve to the pipe connecting the interior of the mould to a source of vacuum, at a position between the mould and the rotating joint.

5. Apparatus according to claim 4 wherein between the non-return valve and the pipe connecting the interior of the mould to a source of vacuum, there is provided a separator for softener distilled from the mould during the heating phase.

6. Apparatus according to claims 3, 4 or 5 wherein a peripheral groove is provided on the periphery of each flange and an annular sealing band is located in the groove.

7. Apparatus according to claim 6 wherein the sealing band is made of silicone rubber.

8. Apparatus according to claim 3 wherein the groove in the flange is connected to a source of vacuum which in its turn is connected through an electro magnetically actuated shut-off valve to the pipe connecting the interior of the mould to a source of vacuum.

9. A method of manufacturing hollow shaped objects from synthetic thermoplastics material substantially as hereinbefore described with reference to the accompanying drawings.

10. Apparatus for the manufacture of hollow shaped objects substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Agents for the Applicant:—
SYDNEY E. M'CAW & CO.
Chartered Patent Agents
Saxone House
52/56 Market Street
Manchester

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

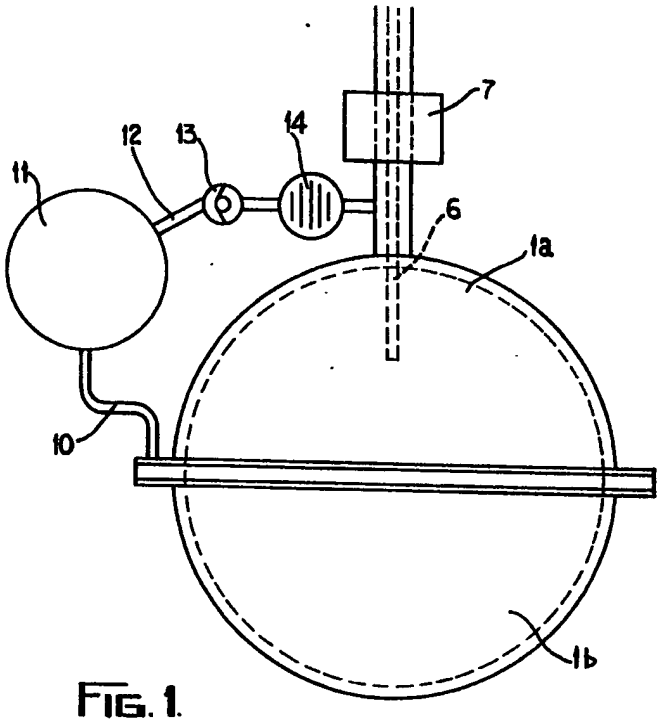

FIG. 1.

1271785 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

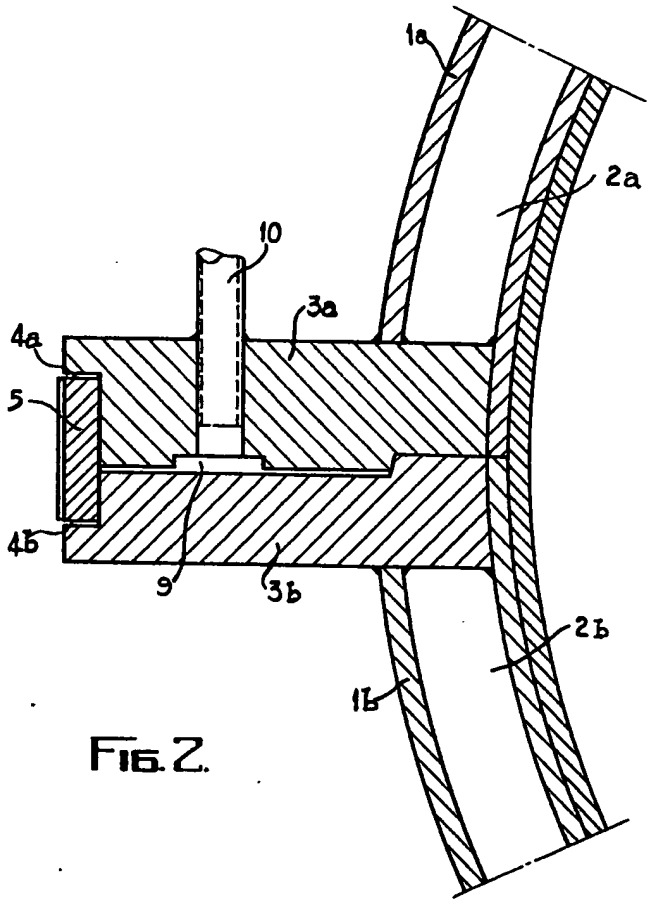

FIG. 2.